Name I.C. LEWIS / T. PIRRO

Notebook Number 195-130

Subject CHEMISTRY OF RAW MATERIALS, NEW BINDERS, + IMPREGNANTS

Dates From ____ To ____

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Subject 2nd VI of 195-129-97 #3-2-B w/ silicon (IV) oxide, colloidal dispersion (c/c COMP BF)
Cross-Reference (if any)

Purpose:

Ref. 195-129-99

Materials:

1) c/c composite 195-129-97 #3-2-B. (c/c composite via BP process from the 2nd block of the 3rd Lawrenceburg trial. 0.25" long K-223-SC pitch fibers. Reilley 155 g. tch. Load ratio = 75 lbs w/o sulfur. VI'ed 1x w/ SiO_2 colloidal dispersion ⇒ hot vac. dried. Wt(i) = 861.58g, Vol(i) = 571.400cc, Den(i) = 1.508 g/cc, Wt(PVD-1) = 903.59g, Current Den = 1.581 g/cc
2) Impregnant: Silicon (IV) oxide, 30% in H_2O, colloidal dispersion. (Alfa-Aesar) Lot # A04K09. 0.01 um particles, in liquid. SA = 320 m^2/g, Density = 1.20, Lot Used: 7/26/01
Visc(i) = 7.7 cps at 82.1°F, SG(i) = 1.216 at 82.1°F

Apparatus:

Ref. 195-120-15

Procedure:

Ref. 195-120-15+16 * Processed w/ 195-129-95 #3-2-A

Pump-Down Data: (7/27-30/01) - Process w/ 195-129-95 #3-2-A

DATE	TIME	PRESS (mm)	Comments
7/27	8:40	16	Load block from hot vac. oven (~166°C, 0.3mm)
"	8:50	"	Begin pump-down
"	10:00	22	Sample is dry ⇒ VI today
"	10:45	14	Charge traps w/ dry ice - acetone
"	11:45	9	LDR
"	13:00	9	Begin VI

Impregnation Data: (7/27-30/01) - LDR w/ traps charged.

LDR: Initial = 9 m Torr Visc(i) = 8.0 cps at 76.2°F
5 min = 21 "
10 min = 30 "
15 min = 41 "
SG(i) = 1.220 at 76.2°F

Drop Time = 13:00 (9 m Torr)
Unload Time = 8:00 (7/30/01)
Held at atmospheric pressure for ~67 hrs.

Comments:

~450 cc of impregnant in the 500 cc cylindrical funnel.

Post-Impregnation Data: (7/30/01)

Wt(PVI-2) = 1011.33g ⇒ Wt Pickup = 107.74g ⇒ wt% Pickup = (11.92), Vol% Pickup = (15.45)

Performed and Recorded by: [signature] **Date**
Directed by: JC Lewis **Date**
Read and Understood by: **Date**

2 **Subject** 2nd VI of 195-129-97 #3-2-B w/silicon (IV) oxide, colloidal dispersion (ck conc BP)
Cross-Reference (if any)

Drying Data: (7/30-31/01) - Oven set "29" (50%). Argon purge at 5.0 SCFH (AIR)

	TIME	OVEN TEMP	PRES (mm)	Comments
*	8:20	112	Atm	Load oven; # to bot, rear of tray. Oven set "29" (50%). Argon purge 5.0 SCFH (AIR)
-(3)	11:20	114	"	Unload oven. Set oven at "28" (50%) Weigh block hot.
	—	—	—	Wt = 981.44g ⇒ wt Pickup = 77.85g ⇒ wt/o Pickup = 8.62 (Yld = 72.3%)
*	11:30	108 (1)	Atm	Load oven; # to top, front of tray. Oven set "36" (50%). Argon purge 5.0 SCFH (AIR)
(2)	13:30	130	"	Unload oven. Set oven at "46" (50%). Weigh block hot. Install new gasketing
	—	—	—	Wt = 942.14g ⇒ wt Pickup = 38.55g ⇒ wt/o Pickup = 4.27 (Yld = 35.8%)
*	14:00	135 (1)	741.3	Load oven; # to bottom, rear of tray, Vac. pump on. Argon purge off.
-(18)	8:00	166	0.3	Vac. pump off. Pressurize w/argon. Set oven at "48" (50%)
	—	—	—	Wt = 939.57g ⇒ wt Pickup = 35.98g ⇒ wt/o Pickup = 3.88 (Yld = 24.1%)

Comments:

1) After 3 hrs, ~113°C, atm. pressure;
Set oven at "38" (50%). Patches of white residue, more than 195-129-100 #3-2-A, on exterior faces (i.e. SiO_2), Rotate 180°; ~~# to bottom~~ top, front of tray

2) After 2 hrs, ~130°C, atm. pressure;
Set oven at "46" (50%). Wipe condensed H_2O from oven door. Remove old gasketing and install new.

3) After 18 hrs, ~165°C, vacuum;
Set oven at "48" (50%). Very small amount of white solid (SiO_2) beneath this block. Powdery, white residue on exterior faces, more than 195-129-100 #3-2-A.

Comments:
As w/the #3-2-A sample the impregnant's % in/to weight yield is lower than expected (i.e. ~31%) ⇒ run-out, or the previous SiO_2 from the 1st VI was dissolved during the 2nd VI.

Cumulative Wt Pickup = 67.99g ⇒ Cumulative % Wt Pickup = 7.89
Previous " " " = 42.01g ⇒ Previous % Wt Pickup = 4.88

Label 195-130-2 #3-2-B

Performed and Recorded by: _____ **Date** / /
Directed by: _____ **Date**
Read and Understood by: _____ **Date**

Subject VI of 195-129-98 #4-13-A1 w/ 195-129-53 (50/50 by vol [illegible]/[illegible]) (c/c conv 3?)
Cross-Reference (if any)

Purpose:

To [illegible] the c/c composite, [illegible], w/ [illegible] resin/[illegible] blend. [illegible] [illegible] is in [illegible].

Materials:

1) c/c composite: 195-129-98 #4-13-A1 (c/c composite via BP process from the 13th block of the 4th [illegible] trial. 0.25" long pitch fibers + Reilley 15 P pitch. Lead ratio = 75/25 w/o sulfur. Graphitized to ~3000°C.), Weight = 277.03g, Vol = 162.42 cc, Density = 1.701 g/cc
Note: This material had 1 PI and rebake prior to graphitization.

2) Impregnant: 195-129-53 (50/50 by vol. GP-1432/Furfural). Prep. 5/14/01, last used: 5/17/01 [illegible] refrigerated. Visc = 17.4 cps at 74.5°F, S.G. = 1.185 at 74.5°F, [illegible] = 34.4 (σ = 0.26, n = 3)

Apparatus:

Ref. 195-120-15

Procedure:

Ref. 195-120-15 [illegible] * Processed w/ 195-129-98 # 4-13-A1

Pump-Down Data: (7/30/01)

Date	Time	Press (mTorr)	Comments
7/30	7:00	16	Load from [illegible] at atm. pressure.
"	8:00	"	
"	9:00	30	⇒ samples are dry
"	11:05	22	Change traps w/ dry ice-acetone
"	11:35	12	LDR
"	13:15	"	Begin VI

Impregnation Data: (7/30 + 31/01) - LDR w/ traps charged.

LDR: Initial = 12 mTorr
5 min = 25 "
10 min = 34 "
15 min = 44 "

Visc = 20.1 cps at 70.8°F
S.G. = 1.174 at 70.8°F

Imp Time = 13:15 (12 mTorr)
Unload Time = 8:15 (7/31/01)
Held at atmospheric pressure for ~17 hrs

Comments:

400 ml of impregnant in 500 ml cylindrical funnel.

Post Impregnation Data: (7/31/01)

Graph: Ref. 195-130-03

Wt (PVI-1) = 317.11g ⇒ Wt. Pickup = 40.08g ⇒ Wt% Pickup = 14.47, Vol% Pickup = 20.61

Performed and Recorded by: [signature] **Date**
Directed by: [signature] **Date**
Read and Understood by: **Date**

4 **Subject** VI & Cure (220°C) of 195-129-98 #4-13-A1 w/ 195-129-53 (c/c comp BP)
Cross-Reference (if any)

Curing Data: (7/31 + 8/01/01) - Cured w/ VI-d 195-129-98 #4-13-B1. Samples placed on S.S. screen over small Al pan to determine amount of run-out.
Al Pan + Screen Wt (I) = 191.07g

	TIME	OVEN SET	OVEN TEMP	Comments
*	8:40	48	164	Load oven. Purge w/ Argon at 5.0 SCFH (AIR)
-(2)	10:40	"	167	Unload to desiccator. Set oven at "82" (50%). Cool composite ⇒ weigh
	—	—	—	Wt: 292.87g ⇒ Wt. Pickup = 15.84g ⇒ wt/o Pickup = 5.72 (Yld = 39.5%)
*	13:30	82	246	Load oven; rotate 180°, reverse position. Purge w/ Argon at 5.0 SCFH (AIR)
-(2)	15:30	"	256	Unload to desiccator. Cool overnight + weigh next morning. Oven set "29" (50%)
	—	—	—	~~Wt = 291.55g ⇒ Wt Pickup = 14.52g ⇒ wt/o Pickup = 5.24 (Yld = 36.2%)~~

Comments:

1) After 2 hrs, ~166°C, atm. pressure;
Run-out evident on S.S. screen and in Al pan. Pan + Screen + Run-out = 195.62g ⇒
Cured run-out = 4.55g (ie, ~~Tot. Cured resin = 20.39g ⇒ Yld = 50.7%~~)
Set oven at "82" (50%), Rotate sample 180° and reverse position w/ the "B1" sample.

2) After 2 hrs, ~251°C, atm pressure;
Set oven to "29" (50%). Transfer samples to desiccator. Cool overnight and weigh 8/1/01.

Post Curing Data: (8/01/01)

Pan + Screen + Cured Run-out (F) = 195.71g ⇒ Cured Run-out = 4.64g

Wt (F) = 291.55g ⇒ Wt Pickup = 14.52g ⇒ Wt/o Pickup = 5.24 (Instr Yld = 36.2%)

~~⇒ Impregnant Yield (including run-out) = [(4.64+14.52)/40.08] x 100 = 47.8%~~

Label 195-130-04 *Taken by Dr Huang w/o label 8/1/01. for machining

⇒ Impregnant Yield (including run-out): Ref. 195-130-06, back to include both wt. pickups for each sample

Performed and Recorded by: Date
Directed by: J Chin Date
Read and Understood by: Date

Subject VI & cure (~250°C) of 195-129-98 #4-13-B1 w/195-129-53 (c/c COMP BP).
Cross-Reference (if any)

Purpose:
Ref. 195-130-03

Materials:
1) c/c Composite: 195-129-98 #4-13-B1 (c/c composite via BP process. From the 13th Block of the 4th Lawrenceburg trial. 0.25" K-223SE Fibers. Ratley 155p. Tech. Loud ratio = 75/25 W/o sulfur. Graphitized to ~3000°C). Note: This material had no PI.
Wt(a) = 255.92g, Vol(a) = 165.987cc, Den(a) = 1.542 g/cc
2) Impregnant: 195-129-53 (50/50 by vol. GP-5432 / Furfural). Prep. 5/14+15/01. Last Use: 5/17. Stored refrigerated. Vis(a) = 17.4cps at 74.5°F, S.G.(a) = 1.188 at 74.5°F, % Mod MCC = 34.4 (σ = 0.26, n=3).

Apparatus:
Ref 195-120-15

Procedure:
Ref. 195-120-15 #16 * Processed w/195-129-98 #4-13-A1

Pump-down Data:

DATE	TIME	PRESS (mm)	Comments
7/30	7:50	16	Load from warm oven at atm. pressure
"	8:00	"	
"	9:00	30	⇒ samples are dry.
"	11:00	22	charge traps w/ Syrie-acetone.
"	11:35	12	LDR
"	13:15	12	Begin VI

Impregnation Date: (@ 7/30+31/01) - LDR w/ traps charged
LDR: Initial = 12 mTorr
5 min = 25 "
10 min = 34 "
15 min = 44 "
Vis(a) = 20.42cps at 70.8°F
S.G.(a) = 1.194 at 70.8°F
Drop Time = 13:15 (12 mTorr)
Unload Time = 8:15 (7/31/01)
Held at atmospheric pressure for ~19 hrs

Comments:
400 ml of impregnant in 500 ml cylindrical funnel.

Post-Impregnation Data: (7/31/01)

Wt(PVI-1) = 308.96g ⇒ Wt Pickup = 53.04g ⇒ Wt% Pickup = (20.73), Vol% Pickup = 26.77

Performed and Recorded by: [signature] **Date** 7/31/01
Directed by: [signature] **Date**
Read and Understood by: **Date**

6 **Subject** VE and Cure (@150°C) of 195-129-98 #4-13-B1 w/195-129-53 (c/c concr
Cross-Reference (if any)

Curing Data: (7/31 + 8/1/01) - Cured w/ VE'ed 195-129-98 #4-13-A1. Samples placed on SS screen over small Al pan to determine vacuum of runout.

Al Pan + Screen Wt (#1) = 191.07g

	TIME	OVEN SET	OVEN TEMP	Comments
*	8:40	48	164	Load oven. Purge w/argon at 50 SCFH (AIR)
-(2)	10:40	"	167	Unload to desiccator. Set oven at "82" (50°C). Cool composite → weigh
	—	—	—	Wt = 277.36g ⇒ Wt Pickup = 21.44g ⇒ wt/o Pickup = 8.38 (%O = 40.4%)
*	13:30	82	246	Load oven. Rotate 180°, reverse position. Purge w/argon at 50 SCFH (AIR)
-(2)	15:30	"	256	Unload to desiccator. Cool overnight + weigh next morning. Oven set "29" (50°C)
	—	—	—	Wt = 275.68g ⇒ Wt Pickup = 19.76g ⇒ wt/o Pickup = 7.72 (%O = 37.3%)

Comments:

1) After 2 Hrs, ~166°C, atm. pressure;
Runout evident on SS screen and in Al pan. Pan + screen + Runout = 195.62g ⇒ Cured run-out = 4.55g
Set oven at "82" (50°C). Rotate sample 180° and reverse position w/ the "A1" sample.

2) After 2 Hrs, ~251°C, atm. pressure;
Set oven to "29" (50°C). Transfer samples to desiccator. Cool overnight and weigh 8/1/01.

Post Curing Data: (8/01/01)

Pan + Screen + Cured Run-out: Ref. 195-130-04

$Wt_{(F)}$ = 275.68g ⇒ Wt Pickup = 19.76g ⇒ wt/o Pickup = 7.72 (Ins. to Vol = 37.3%)

Label 195-130-06 *Taken by D. Huang w/o label 8/1/01 for machining.

⇒ Impregnant Yield (including run-out from both samples) = (4.64 + 14.52 + 19.76)/60.08 + .
= (38.92/93.12) × 100 = 41.8%

Performed and Recorded by: [signature] **Date** / /
Directed by: [signature] **Date**
Read and Understood by: **Date**

Subject Initial Data of Graphitized c/c composites via BP Process (4th Trial) (c/c comp BP) 7

Cross-Reference (if any) Ref. 195-129-98 (comparisons at 3000°C graph temp).

Purpose:

To obtain the initial weights and dimensions prior to vacuum impregnation w/ "T-143" type phenolic/Furfural resin blend for densification.

Materials:

c/c composites via BP process. Rec'd from R. Sirocky 8/7/01. Two sections; both graphitized to ~3200°C. Section "A-2" had one pitch impregnation, section "B-2" had not.
Made w/ 0.25" K-223 SE pitch fibers and Reilley 15S pitch. Load ratio = 75/25. No solv.
Batch B of 4th Lawrenceburg trial.

Procedure:

Ref. 195-129-96

Initial Data: (8/8/01)

File path = c:\Program Files\Excel\BP c-c composites\Initial.xls Sheet = BP IV (appended).

Material:

Material: BP-IV-13 A2 and BP-IV-13 B2. Rec'vd 8/07/01. Ultrasonic washed 3x for 5 min. in deionized water on 8/07/01. Dimensions were obtained with a Mitutoyo Model CD-8"CS digital caliper. Hot vacuum dried at 99 °C to 0.3 mm pressure from 8/07 to 8/08/01. Weights obtained on Mettler PN 2210 balance on 8/08/01.
Note: Both samples have been graphitized to ~3200°C. A2 has one PI. B2 has no PI.

Sample I.D.	Weight (g)	L1 (mm)	L2 (mm)	L3 (mm)	Ave. Length (mm)	W1 (mm)	W2 (mm)	W3 (mm)	Ave. Width (mm)	H1 (mm)	H2 (mm)	H3 (mm)	Ave. Height (mm)	Vol. (cc)	Den. (g/cc)
4-13-A2	266.87	107.91	108.23	108.10	108.08	93.92	93.98	94.11	94.00	15.16	15.29	15.38	15.28	155.209	1.719
4-13-B2	257.29	107.46	107.84	108.12	107.81	97.75	98.11	98.78	98.21	15.34	15.49	15.34	15.39	162.950	1.579

Dimensioned: 08/08/01
Hot Vac. Dried: 08/07-08/01
Weighed: 08/08/01
N.B. Ref. No. : 195-130-07

#	Impregnant	NB Ref.
4-13-A2	195-129-53 (50/50 v/o GP5432/Furfural)	195-130-08 & 09
4-13-B2	" " " (" " " / ")	195-130-10 & 11

Performed and Recorded by: [signature] **Date** / /
Directed by: [signature] **Date**
Read and Understood by: **Date**

8 **Subject** VI of 195-130-07#Y-13-A2 w/195-129-53 (50/50 Vol% GP-5432/furfural) (C/C comp
Cross-Reference (if any)

Purpose:
To densify a graphitized c/c composite w/a phenolic/furfural resin blend. Proposed use is a Li cell.

Materials:
1) c/c Composite: 195-130-07#Y-13-A2 (c/c composite via BP process. From the 13th block of the 4th Lawrenceburg trial. 0.25" long K-223-SE pitch fibers + Reilley 155 p. tch, Load Ratio = 75% w/o sulfur. Piece ⇒ rebaked. Graphitized to ~3200°C). $Wt_{(1)}$ = 266.87g, $Vol_{(1)}$ = 155.209cc $Den_{(1)}$ = 1.719 g/cc
2) Impregnant: 195-129-53 (50/50 by vol. GP-5432/furfural) Prep 5/14+15/01. Stored in refrigerator. Last Used: 7/31/01. $Vis_{(1)}$ = 17.4cps at 74.5°F, $SG_{(1)}$ = 1.188 at 74.5°F. % Med mC = 34.4 (σ = 0.26, n=3).

Apparatus:
Ref. 195-120-15

Procedure:
Ref. 195-120-15+16. * Processed w/195-130-07#Y-13-B2

Pump-down Data: (8/8+9/01)

DATE	TIME	PRESS (mTorr)	Comments
8/8	13:00	18	Load core from hot vac. oven (132°C, 0.4mm)
"	13:10	"	Begin pump-down
"	14:10	35	
"	16:00	25	
8/9	8:15	22	Charge traps w/dryice-acetone.
"	8:40	13	LDR
"	9:45	12	Begin V.I.

Impregnation Data: (8/9+10/01) - LDR w/traps charged
LDR: Initial = 13 milli.torr $Vis_{(1)}$ = 17.9 cps at 77.7°F Prep Time = 9:45 (12 mTo
5 min = 25 " $SG_{(1)}$ = (1.192) at 77.7°F Unload Time = 7:45 (8/10/0
10 min = 34 "
15 min = 44 "

Comments:
300 ml of impregnant in the 500 ml cylindrical funnel.

cont'd next page.

Performed and Recorded by: T. Tucci **Date** / /
Directed by: J Chu **Date**
Read and Understood by: **Date**

Subject VI of 195-130-07 #4-13-A2 w/ 195-129-53
Cross-Reference (if any)

Post Impregnation Data: (8/10/01)

Wt (PVI-1) = 302.95g ⇒ Wt. Pickup = 36.08g, ⇒ wt/o Pickup = 12.52; Vol/o Pickup = 19.50

Curing Data: (8/10/01) - Cured w/ vized 195-130-07 #4-13-B2. Samples were placed atop a s.s. screen over a small Al pan, to determine the amount of cured run-out.
Al pan + Screen Wt (I) = 190.85g

	Time	Oven Temp	Oven Press.	Comments
*	8:05	154	Atm	Load oven, Purge w/ argon at 5.0 SCFH (Air).
-(2½)	10:35	150	"	Unload to desiccator. Set oven at "82" (50%). Cool composite ⇒ weigh.
	—	—	—	Wt = 281.70g ⇒ Wt Pickup = 14.83g ⇒ wt/o Pickup = 5.56 (Vol = 41.1%)
*	12:35	248	Atm	Load oven; rotate 180°, reverse position. Purge w/ argon at 5.0 SCFH (Air).
-(2)	14:35	252	"	Unload to desiccator. Set oven "29" (50%). Cool ⇒ weigh.
	—	—	—	Wt = 280.12g ⇒ Wt Pickup = 13.25g ⇒ wt/o Pickup = 4.96 (Vol = 36.7%)

Comments

1) After 2½ hrs, ~152°C, atm. pressure;
Set oven at "82" (50%). Evidence of run-out on the screen and in Al pan.
Rotate sample 180° (front of oven). Unload to desiccator ⇒ cool ⇒ weigh.

2) After 2hrs, ~250°C, atm. pressure;
Set oven at "29" (50%). Unload to desiccator ⇒ cool ⇒ weigh.

Post Curing Data: (8/10/01)

Pan + Screen + Cured Run-out (F) = 194.79g ⇒ Cured run-out = 3.84g

Wt (F) = 280.12g ⇒ Wt Pickup = 13.25g ⇒ wt/o Pickup = 4.96, (In situ % Vol = 36.7)

Label 195-130-09 #4-13-A2 Given to P. Sinocky 8/13/01

Impregnant Yield Including Run-out: Ref. 195-130-11

Performed and Recorded by: Date
Directed by: Date
Read and Understood by: Date

Subject VI of 195-130-07 #4-13-B2 w/195-125-53 (50/50 vol% GP-5432/Furfural) (ck comp...

Cross-Reference (if any)

Purpose:

Ref. 195-130-08

Materials:

1) c/c Composite: 195-130-07 #4-13-B2 (c/c composite via BP process from the 13th block of the 4th Lowrencebury trial. 0.25" long K-223-SE pitch fibers + Reilley 15.5 pitch, ... no solvent. NO PI, Graphed to ~3200°C) Wt(g) = 257.29g, Vol(cc) = 162.950cc, D(g/cc) = 1.57

2) Impregnant: 195-129-53 (50/50 by vol. GP-5432/Furfural). Prep. 5/... , stored in refrigerator. Last used: 8/10/01, Visc = 13.4 cps at 74.5°F, S.G. = 1.189 at 78.1°F

% MaD MCC = 34.4 (n = 6, ... = 3)

Apparatus:

Ref. 195-120-15

Procedure:

Ref. 195-130-15+16 * Processed w/ 195-130-08 #4-13-A2

Pump Down Data: (8/08+09/01)

DATE	TIME	PRESS (mTORR)	comments
8/8	13:00	18	Load sample from hot oven (132°C, 0.4mm)
"	13:10	"	Begin pump-down.
"	14:00	35	
"	16:00	25	
8/9	8:15	22	Charge traps w/ dry ice-acetone
"	8:40	13	LDR
"	9:45	12	Begin VI

Impregnation Data: (8/09+10/01) - LDR w/ traps charged.

LDR: Initial = 13 mTorr   Visc = (17.9) cps at 77.7°F   Drop time = 9:45 (...)

5 min = 25 "   S.G. = (1.192) at 77.7°F   Unload Time = 7:45 (8/10)

10 min = 34 "   Held at atmospheric pressure for

15 min = 44 "   ~22 hrs.

Comments:

300 ml of impregnant in the 500 ml cylindrical funnel.

Post Impregnation Data: (8/10/01)

Wt(PVI) = 308.14g, ⇒ wt Pickup = 50.85g ⇒ wt% Pickup = (19.76), vol% Pickup = 26.18

Performed and Recorded by: [signature]   **Date** / /

Directed by: [signature]   **Date**

Read and Understood by: **Date**

Subject VI of 195-130-07 #4-13-B2 w/195-128-53 (50/50 Vol/o 6P-5432/Furfural) (c/c comp BP)
Cross-Reference (if any)

Curing Data: (8/10/01) - cured w/ VI-ed 195-130-07 #4-13-A2. Samples were placed atop a s.s. screen over a small Al pan to determine the ~amount of cured run-out.

Al pan + screen (cf) = 190.95g

	Time	Oven Temp	Press (mm)	Comments
*	8:05	154	Atm	Load oven. Purge w/argon at 5.0 SCFH (AIR). Oven set at "48" (50%).
-(2½)	10:35	150	"	Unload to desiccator. Set oven at "82" (50%). Purge w/argon at 5.0 SCFH (AIR)
	—	—	—	Wt = 278.68g ⇒ Wt Pickup = 21.39g ⇒ wt/o Pickup = 8.31 (Yld = 42.1%)
*	12:35	248	Atm	Load oven; rotate 180°, reverse position. Purge w/argon at 5.0 SCFH (AIR).
-(2)	14:35	252	"	Unload to desiccator. Set oven at "29" (50%). Cool ⇒ weigh.
	—	—	—	Wt = 276.35g ⇒ Wt Pickup = 19.06g ⇒ wt/o Pickup = 7.41 (Yld = 37.5%)

Comments:

1) After 2½ hrs, ~152°C, atm. pressure; Set oven at "82" (50%). Evidence of run-out on the screen + in the Al pan. Rotate sample 180° (rear of oven). Unload to desiccator ⇒ cool ⇒ weigh.

2) After 2 hrs, ~250°C, atm. pressure; Set oven at "29" (50%). Unload to desiccator ⇒ cool ⇒ weigh.

Post Curing Data: (8/10/01)

Pan + Screen + Cured Run-out (cf) = 194.79g ⇒ Cured Run-out = 3.84g

Wt (cf) = 276.35g ⇒ Wt Pickup = 19.06g ⇒ wt/o Pickup = (7.41) (In-situ % Yld = 37.5)

Impregnant Yield (including run-out) = [(3.84 + 19.06 + 13.25)/(36.08 + 50.85)] × 100
= (36.15/86.93) × 100 = 41.6%

this agrees well w/ impregnant yield from A1 + B1 samples Ref. 195-130-06 (i.e. 41.8% yield).

Labeled 195-130-11 #4-13-B2 Given to P. Sirocky 8/13/01

1

Performed and Recorded by: [signature] **Date**
Directed by: J. Chu **Date**
Read and Understood by: **Date**

Subject Graphitization of 195-129-93 # 3-1-B, 195-129-100 # 3-2-A, & 195-130-02 # 3-2-B (Alcoa AP)
Cross-Reference (if any)

For convenience samples were new labeled 195-130-63 # 3-1-B, 3-2-A, & 3-2-B.
Returned to F. Stanley 10/01/01.

Material:

195-130-63 # 3-1-B: Previously 195-129-93 # 3-1B; c/c composite via CP process from the 1st block of the 3rd Lawrence buy trial. 0.25" long K-223-SE pitch fibers and Reilley 155 pitch. Load ratio = 75/25. No sulfur. Used w/ silicon oxide colloidal dispersion 1x ⇒ vacuum dried to 160°C to 0.4 mm, Wt wet: 823.65g, Vol wet: 554.502cc, Density: 1.485g Wt (rvd-1) = 863.85g

Graph Cycle:

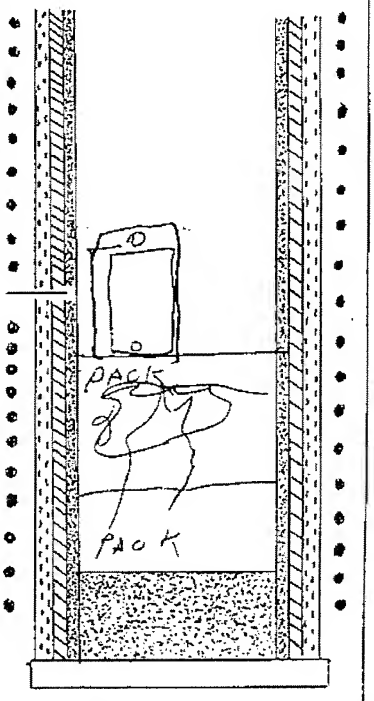
Held 5hrs at ~1690°C ⇒ 1hr at ~2000°C. Block wrapped in Grafoil sheet.

Graph Run Data:

RUN NO. 2 OF 4 NO. PIECES 1
OPERATOR Harlow mix SIZE N 2
(1) 2 RATE FAST TO 1690 hold 5hr 3mlr TO 2000 N ARGON
GROUND CURRENT 2.85 Hold 1hr FREQ. 425

0 - 2400 HR. TIME	SCHED. TEMP.	ACTUAL TEMP.	VOLTS	AMPS	% KW
4	R+	18	26	15	7
5		701	41	21	15
6		1225	53	25	23
7		1690	63	33	31
8	1690	1690	46	23	18
9	1690	1695	45	22	17
10	1690	1705	45	22	17
11	1690	1700	45	22	17
12	1690	1700	43	21	16
1230	2000	2000	78	35	35
1330	2000	2010	54	24	22

LOADING DIAGRAM



COMMENTS
@ 925
SiC TUBE

Performed and Recorded by: Date
Directed by: Date
Read and Understood by: Date

64 **Subject** Graphitization of 195-129-93 #3-1-B, 195-129-100 #3-2-A, 195-130-01 #3-2-B
Cross-Reference (if any)

Post Graph Comments:
Very little SiC on the sample. Same is true for the grafoil wrap.

Material:
195-130-63 #3-2-A; Previously 195-129-100#3-1-A; c/c composite via BP process from 2nd block of the 3rd Lawrenceburg trials. 0.25" long K-223-SE pitch fibers and Ref Ley 15 pitch. Load Ratio = 20/20. No sulfur. Used silicon oxide colloidal dispersion 2x + hot vacuum dried after each VI. Final Vac dry (166°C, 0.3mm). $Wt_{(2)}$ = 867.13g, $Vol_{(2)}$ = 556.247g/cc, $Density_{(2)}$ = 1.559g/cc, $Wt_{(PVD-2)}$ = 926.16g

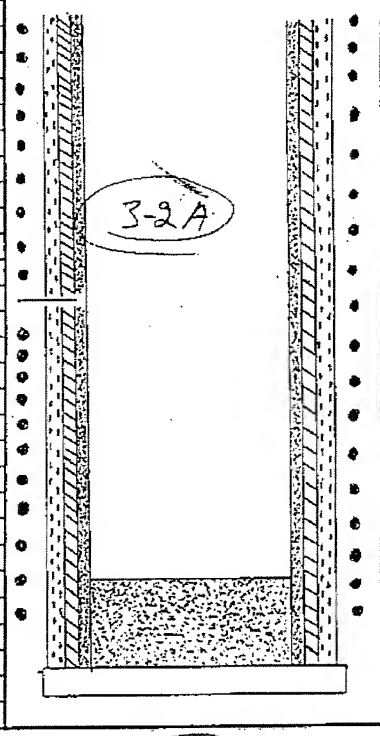
Graph Cycle:
Held 5 hrs at ~1700°C ⇒ 1 hr hold at ~2400°C. Block wrapped in Grafoil sheet.

Graph Run Data:

COIL NO. 10 DATE 9-20-01 SUBMITTER D. HUANG
RUN NO. 3 OF 4 NO. PIECES 1
OPERATOR JIM-HARLEN MIKE SIZE N 2
① 2 RATE 1700° 5 HRS → 2400° 1 HR ARGON
GROUND CURRENT 301 FREQ. 428

0 - 2400 HR. TIME	SCHED. TEMP.	ACTUAL TEMP.	VOLTS	AMPS	% KW
2	RT	20	27	15	7
3	700	670 x	40	21	15
4	1200	1210	53	25	23
5	1700	1695	64	32	32
6	1700	1695	47	23	19
7	1700	1690	45	21	17
8	1700	1705	44	21	17
9	1700	1700	43	21	16
10	1700	1705	44	21	17
11	2050	2110	69	35	55
1695	2400	2400	81	47	47
1245	2400	2405	67	34	33

LOADING DIAGRAM



COMMENTS
x 785g

Performed and Recorded by: Date,
Directed by: J C Lee Date
Read and Understood by: Date

Subject Graphitization of 195-129-100 #3-2-A & 195-130-02 #3-2-B. (c/c Comp BP)

Cross-Reference (if any)

Post Graph Comments:

Most visible SiC on surfaces of the block of the three samples run here. Appreciably more SiC on the Grafoil Wrap than the block taken to 2000°C.

Material:

195-130-63 #3-2-B: Previously 195-130-02 #3-2-A: ck composite via BP process from the 2nd block of the 3rd Lawrenceburg trial. 0.25" long K-223-SE pitch fibers and Reilley 155° pitch. Load Ratio = 75/25. No sulfur. Used silicon oxide colloidal dispersion 2x ⇒ hot vacuum dried after each VJ. Final vac dry (166°C, 0.3mm). Wt(ck) = 861.58g, Vol(ck) = 571.400cc, Den(ck) = 1.508g/cc, Wt(PVB-2) = 929.57g

Graph Cycle:

Held 5hrs at ~1700°C ⇒ 1 hr hold at ~2600°C. Block wrapped in Grafoil sheet.

Graph Run Data:

COIL NO. 10 DATE 7-25-01 SUBMITTER D. ITUHA

RUN NO. 4/4 NO. PIECES 1

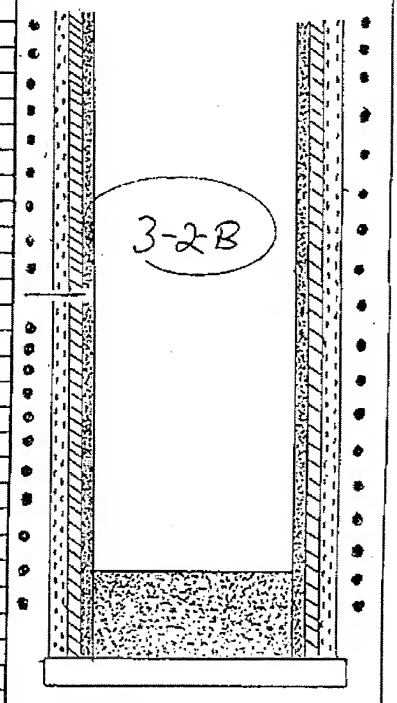
OPERATOR JIM-HARLEN-MIKE SIZE N2

(1) 2 RATE FAST 1700° HOLD 5HRS 300°/HR ⇒ 2600° HOLD 1HR ARGON

GROUND CURRENT 290 FREQ. 426

0-2400 HR. TIME	SCHED. TEMP.	ACTUAL TEMP.	VOLTS	AMPS	% KW
1	RT	13	26	15	6
2	700	690	41	21	15
3	1200	1215	51	25	22
4	1700	1680	65	33	32
5	1700	1705	47	23	19
6	1700	1700	45	22	17
7	1700	1705	44	21	16
8	1700	1708	44	21	17
9	1700	1703	43	20	16
10	2200	2200	81	47	47
11	2600	2540	93	61	62
12	2605	2605	72	39	39

LOADING DIAGRAM



COMMENTS

Performed and Recorded by: T. Perio **Date** / /

Directed by: J C Lin **Date**

Read and Understood by: **Date**

66 **Subject** Graph of 195-129-03 #3-1-B, 195-129-100 #3-2-A, & 195-130-02 #3-2-B (c/c comp BP)
Cross-Reference (if any)

Post Graph Comments:

Visible SiC on sample's surfaces. Possibly less than 195-130-63 #3-2-A. Of three samples this material had the most coating of SiC on the Grafoil wrap. The Grafoil wrap was given to J. Norley to evaluate potential of Si coated Grafoil.

Post Graph Data: (9/28/01)

File Path = C:\Program Files\Excel\BP C-C Composites\Post Graph.xls Sheet = BP III

BP C/C COMPOSITES POST GRAPH WEIGHTS AND DIMENSIONS

Material:

Material: BP-III-1 and BP-III-2. Rec'vd 09/28/01. Samples not washed (ie. Vac oven out of order).
Dimensions were obtained with a Starrett No. 123-12 vernier caliper.
Weights obtained on Mettler PN 2210 balance on 9/28/01.

Sample I.D.	Weight (g)	L1 (in.)	L2 (in.)	L3 (in.)	Ave. Length (in.)	W1 (in.)	W2 (in.)	W3 (in.)	Ave. Width (in.)	H1 (in.)	H2 (in.)	H3 (in.)	Ave. Height (in.)	Vol. (cc)	Den. (g/cc)
3-1-B	810.66	8.267	8.277	8.286	8.277	3.269	3.319	3.327	3.305	1.254	1.149	1.228	1.210	542.540	1.494
3-2-A	852.69	8.939	8.938	8.956	8.944	3.245	3.304	3.316	3.288	1.209	1.119	1.195	1.174	565.998	1.507
3-2-B	836.79	8.978	8.982	8.993	8.984	3.295	3.332	3.324	3.317	1.162	1.165	1.165	1.164	568.439	1.472

Dimensioned: 09/28/01
Hot Vac. Dried: N/A
Weighed: 09/28/01
N.B. Ref. No. : 195-130-63

	Initial through Graph						Post Vacuum Dry through Graph					
Sample I.D.	Wt/o	Len/o	W/o	H/0	Vol/o	Den/o	Wt/o	Len/o	W/o	H/0	Vol/o	Den/o
3-1-B	-1.58	0.96	1.01	-4.12	-2.16	0.61	-6.16	NM	NM	NM	NM	1.228
3-2-A	-1.67	0.94	0.77	0.00	1.75	-3.34	-7.93	NM	NM	NM	NM	1.195
3-2-B	-2.88	0.89	1.16	-2.51	-0.52	-2.39	-9.98	NM	NM	NM	NM	1.165

Comments:

Dimensionally the sample shrinks in thickness (ie. height). This resu
In expansion in the other two directions.
No where near 1.70 final density desired.

Samples Returned to P. Siracky 10/01/01.

Performed and Recorded by: [signature] **Date**
Directed by: [signature] **Date**
Read and Understood by: **Date**

Subject Initial Data - c/c Composite via BP Process (1st Trial - no graph) (c/c comp BP)
Cross-Reference (if any)

Purpose:
To obtain the initial weights & dimensions prior to vacuum impregnation w/ "T-143" type phenolic/furfural resin blend for densification.

Material:
c/c composite via BP process. Rec'd from P.S. Rocky 10/23/01. This was a slab from the 7th brick of the 1st trial. Slab was not graphitized. Made w/ 0.25" K-223-SE pitch fibers, Reilley VST pitch, and sulfur. The load ratio = 75/25 + 5 wt% of pitch sulfur.

Procedure:
Ultrasonic washed in deionized water 3x, 5 min intervals ⇒ Vacuum dried overnight in National Vac. Oven (E-15) overnight at ~98°C to 0.5mm pressure. Cooled to R.T. in desiccator ⇒ weighed.

Initial Data: (10/23-24/01)
File Path = C:\Program Files\Excel\BP C-C composites\Initial.xls Sheet = BP I

BP C/C COMPOSITES INITIAL WEIGHTS AND DIMENSIONS

Material:
Material: BP-I-7: not graphitzed. Rec'vd 10/23/01. Ultrasonic washed 3x for 5 min. in deionized water on 10/23/01. Dimensions were obtained with a Starrett No. 123-12 vernier caliper. Hot vacuum dried at 98 °C to 0.5 mm pressure from 10/23 to 10/24/01. Weights obtained on Mettler PN 2210 balance on 10/24/01.

Sample I.D.	Weight (g)	L1 (in.)	L2 (in.)	L3 (in.)	Ave. Length (in.)	W1 (in.)	W2 (in.)	W3 (in.)	Ave. Width (in.)	H1 (in.)	H2 (in.)	H3 (in.)	Ave. Height (in.)	Vol. (cc)	Den. (g/cc)
1-7-A	429.50	8.060	8.050	8.042	8.051	2.648	2.677	2.703	2.676	0.836	0.795	0.750	0.794	280.192	1.533

Dimensioned: 10/23/01
Hot Vac. Dried: 10/23-10/24/01
Weighed: 10/24/01
N.B. Ref. No. : 195-130-79

1st VI w/ T-143: Ref. 195-130-81+82

Performed and Recorded by: T. Rousseau Date 11/1/01
Directed by: J C Lee Date
Read and Understood by: Date

80 **Subject** Preparation of ~500 ml of 50/50 by Vol GP-5432 Kraft-A1 Lab comp B+

Cross-Reference (if any) Previous Treat: Ref. 195-129-53

Purpose:

To ensure enough impregnant for 2 VIs of 195-130-79 #1-4A. This will be combined w/ 195-129-53 prior to impregnation.

Materials:

GP-5432; Lot # 19588. Rec'd from Georgia-Pacific 9/24/96, LIMS # A96-03631. Stored in freezer in E-13, Ave % MeOMCC = 48.6 (σ-0.37, n=3), Brkfld RT Visc = 157.3 cPs at 71.0°F, PDSC Data: Ref. 195-103-49, TGA Yield (900°C) = 47.5%, Brkfld Visc (5/14/01) = 283.5 cPs at 68.7°F.

Furfural: Reagent Grade (Fisher), Rec'd 5/15/01. 1L bottle. Use ~250 ml ⇒ Balance = ~640 ml.

Preparation: (10/25/01) - 1L Erlenmeyer Flask. 250 ml GP-5432 + 250 ml Furfural Stir for ~30 min, stoppered ⇒ combine w/ 195-129-53 Obtain Brkfld (LVT) RT viscosity and RT Specific Gravity

Flask (etc) + GP-5432 (g): 739.0	Flask (etc) + Furfural (g): 1020.3
Flask (etc) (g): 436.8	Flask (etc) (g): 734.0
~250 ml GP-5432 (g): 303.2 g	~250 ml Furfural (g): 286.3 g ⇒ 51.04% Bg wt GP-5432

Mix w/o heat for ~30 min ⇒ combine w/ 195-129-53

Brookfield (LVT) RT Viscosity: (10/25/01)

Viscosity = 19.9 cps at 74.2°F Spindle #1, 60 RPM, Factor = 1

Specific Gravity at RT: (10/25/01)

S.G. = 1.194 at 74.2°F

Label combined solutions 195-130-80. Store in refrigerator when not in use.

Performed and Recorded by: [signature] **Date** 10/25/01

Directed by: [signature] **Date**

Read and Understood by: **Date**

Subject 1st VI of 195-130-79 #1-7-A w/ 195-130-80 (50/50 by vol GP-5432/Furfural) (c/c comp BP)
Cross-Reference (if any)

Purpose:

To densify c/c composite produced via BP process. Note: this composite has not been graphitized.

Materials:

1) c/c Composite: 195-130-79 #1-7-A (c/c composite via BP process) Rec'd From P. Smocky 10/23/01 (7th Block of 1st Lawrence buy Trial, not graphitized), 0.25" long K-223-SE pitch fibers : Reilley 105 pitch + sol'fur. load ratio = 75/25 + 5 pph wt/o of pitch = sol'fur. Wt(c) = 429.50 g, Vol(c) = 280.192 cc, Den(c) = 1.533 g/cc
2) Impregnant: 195-130-80 (50/50 by volume GP-5432/Furfural). Prep. 5/14+15/01. Refrigerated. Add'l Sol'n ? (Y)/N ! (195-130-80) and combined. Last Used: 8/10/01. New Initial Data: Vis(c) = 19.9 cks at 74.2°F, S.G.(c) = 1.194 at 74.2°F

Apparatus:

Ref. 195-120-15

Procedure:

Ref. 195-120-15+16

Pump-down Data: (10/24+25/01)

DATE	TIME	PRESS (mTorr)	Comments
10/24	13:25	9	Load core from desiccator,
"	13:35	"	Begin pump-down
"	14:45	26	
"	16:00	18	
10/25	7:25	12	
"	9:05	13	Charge traps w/ dryice-acetone
"	9:35	7	LDR
"	11:45	6	Begin VI

Impregnation Data: (10/25+26/01) - LDR w/ traps charged

LDR: Initial = 7 mTorr
5min = 16 "
10min = 23 "
15min = 30 "

Vis(c) = 19.9 cPs at 74.2°F
S.G.(c) = 1.194 at 74.2°F

Drop Time = 11:45 (6 mTorr)
Unload Time = 8:45 (10/26/01)
Held at atmospheric pressure for ~ 21 hrs.

Comments:

500 ml cylindrical Funnel is full (ie ~640 cc). ~30 ml returned to 16 oz bottle.
⇒ plenty for at least 2 more VIs.

cont'd next page

Performed and Recorded by: [signature] **Date**
Directed by: J Chu **Date**
Read and Understood by: **Date**

Subject 1st VI of 195-130-79 #1-7-A w/195-130-80 (50/50 vol% CP-5432/Furfural) Calc comp BP
Cross-Reference (if any)

Post Impregnation Data: (10/26/01)

Wt (PVI-A) = 494.21g ⇒ wt. Pickup = 64.81g ⇒ wt% Pickup = 15.09, vol% Pickup = 19.6
Al Pan + Screen wt = 190.94g

Curing Data (10/26/01) - Placed atop S.S. screen over small Al pan. Held ~2 hrs at ~150°C ⇒ ~2 hrs at ~270°C, purged at 20 SCFH (Air) w/ argon throughout.
First Use of Fisher Scientific Isotemp Vacuum Oven (Model #282A).

	Time	Oven Temp	Press (mm)	Comments
+	9:00	153	Atm	Load oven. Oven set at 155°C. Purge w/ argon at 20 SCFH (Air)
- (2)	11:00	153	"	Unload to desiccator. Set oven at 265°C
	–	–	–	wt = 462.86g ⇒ wt. Pickup = 33.36g ⇒ wt% Pickup = 7.77 (Yield = 51.5%)
+	12:00	275	Atm	Load oven, rotate 180°. Set oven at "280°C". Purge w/ argon at 20 SCFH (Air).
- (2)	14:00	271	"	Unload to desiccator. Set oven at 100°C. Allow sample to cool ⇒ weigh
	–	–	–	Wt = 457.84g ⇒ wt Pickup = 28.34g ⇒ wt% Pickup = 6.60 (Yield = 43.7%)

Comments:

1) After 2 hrs, ~153°C, atm pressure;
Set oven at 265°C. Screen & pan contains minor amount of cured resin ⇒ run-out. Top surface has cured "bubbles", while bottom surface has cured "droplets". Rotate 180° (i.e., droplets on top).

2) After 2 hrs ~273°C, atm pressure;
Set oven to 100°C. Unload to desiccator ⇒ cool ⇒ weigh. Scrape "bubbles" "droplets" from composite surface ⇒ reweigh. Store in desiccator over weekend. Load into oven at ~100°C on 10/29/01.

Post Cure Data:
Sample scraped ⇒ reweighed.
wt = 457.58g ⇒ wt Pickup = 28.08g ⇒ wt% Pickup = 6.54, Yield = 43.3%

Pan + screen + cured Resin (wt) = 191.28g ⇒ Cured run-out = 0.34g
Total Cured Run-out (includes cured resin scraped from composite) = 0.34 + 0.26g = 0.60g

Impregnant Yield (including run-out + scrapings) = [(0.60g + 28.08g) / 64.81g] × 100 = 44.3%

2nd VI: Ref. 195-130-85+86

Performed and Recorded by: [signature] Date
Directed by: [signature] Date
Read and Understood by: Date

Subject 2nd VI of 195-130-82# 1-7-A w/ 195-130-80 (50/50 vol/o GP-5432 / furfural) (c/c comp BP)
Cross-Reference (if any)

Purpose:
Ref. 195-130-81

Materials:
1) c/c composite via BP process: 195-130-82# 1-7-A. Rec'd from P. Sirocky 10/23/01. (7th Block of 1st Lawrenceburg Trial); not graphitized). 0.25" long K-223-SE pitch fibers, Reilley 155 pitch, + sulfur, Load Ratio = 72/25 + 5pph wt/o of pitch = sulfur. VI'ed and cured 1x w/ 195-130-80. Wt(c) = 429.50g, Vol(c) = 280.192cc, Den(c) = 1.533g/cc, Wt(PVO-1) = 457.58g, Current Den = 1.633g/cc
2) Impregnant: 195-130-80 (50/50 by volume GP-5432 / furfural) Prep. 5/14+15/01 and 10/25/01. Last Used: 10/20 h
Vis(c) = 19.9 cps at 74.2°F, S.G.(c) = 1.194 at 74.2°F. Refrigerated when not in use.

Apparatus:
Ref. 195-120-15
Procedure:
Ref. 195-120-15 #16

Pump-down Data: (10/29+30/01)

DATE	TIME	PRESS (mTorr)	Comments
10/29	8:30	9	Load cure from warm oven; ~94°C, atm. pressure.
"	8:40	"	Begin pump-down
"	9:40	105	
"	14:00	46	
10/30	7:30	26	
"	8:10	27	Charge traps w/ dryice-acetone
"	9:15	18	LDR
"	11:45	18	Begin VI

Impregnation Data: (10/30+31/01) - LDR w/ traps charged.
LDR: Initial = 18 mTorr
5min = 35 "
10min = 47 "
15min = 53 "
Vis(c) = 18.7 cps at 76.9°F
S.G.(c) = 1.193 at 76.9°F
Drop Time = 11:45 (18 mTorr)
Unload Time = 8:45 (10/31/01)
Held at atmosphere pressure for ~21 hrs.

Comments:
~ 610ml in 500cc cylindrical funnel → Enough for another impregnation.

Post Impregnation Data: (10/31/01)

Wt(PVI-1) = 491.45g ⇒ Wt. Pickup = 33.87g ⇒ Wt% Pickup = 7.40, Vol% Pickup = 10.13

Performed and Recorded by: J Clare **Date**
Directed by: J Clare **Date**
Read and Understood by: **Date**

Subject 2nd VI of 195-130-82 #1-7-A w/195-130-86 (50/50 vol% GA1822/Furfural) (ck comp RP)

Cross-Reference (if any)

Curing Data: (10/31/01).

Procedure: Ref. 195-130-82

Al Pan + Screen wt = 190.97g

	TIME	OVEN TEMP	PRES (mm)	Comments
*	8:55	156	Atm	Load oven. Oven at 155°C. Purge w/argon at 5.0 SCFH (Air).
(2)	10:55	154	"	Unload to desiccator. Set oven at 265°C.
	—	—	-	Wt = 480.83g ⇒ wt pickup = 23.25g ⇒ wt% pickup = 5.08 (Yld = 68.6%)
*	12:00	275	Atm	Load oven, rotate 180°. Set oven at 260°C, Purge w/argon at 5.0 SCFH (Air)
(2)	14:00	271	"	Unload to desiccator. Set oven at 105°C. Allow sample to cool ⇒ weigh ⇒ sc
	—	—	-	Wt = 476.22g ⇒ Wt Pickup = 18.71g ⇒ wt% Pickup = 4.09 (Yld = 55.2%)

Comments:

1) After 2hrs, ~155°C, atm pressure;
Set oven at 265°C. Transfer to desiccator ⇒ cool ⇒ weigh. Composite has numerous cured resin bubbles on all surfaces. Rotate 180°.

2) After 2hrs, ~273°C, atm pressure;
Set oven at 105°C. Transfer to desiccator. Cool ⇒ weigh ⇒ scrape "bubbles" ⇒ reweigh. Store in desiccator.

Post Cure Data: (11/1/01)

Sample scraped ⇒ reweighed:
Final wt = 474.62g ⇒ wt. Pickup = 17.05g ⇒ wt% Pickup (= 3.73), Yield (= 50.3%)

Pan + Screen + Cured Run-out = 191.18g ⇒ Cured run-out = 0.21g
Total Cured Run-out (includes cured resin scraped from composite) = 0.21 + 1.66g = 1.87g

Impregnant Yield (includes run-out & scraping) = [(1.87 + 17.05)/33.87] × 100 = 55.9%

Cumulative Wt Pickup = 45.13g ⇒ Cumulative Wt% Pickup (= 10.51)

Label in plastic bag: 195-130-86 #1-7-A.

Performed and Recorded by: [signature] Date

Directed by: [signature] Date

Read and Understood by: Date